Patent Application

of

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for

I-Joist Hole Cutting Apparatus

PRIORITY CLAIM

The present invention claims priority to the US Provisional Application No. 60/451,225 filed 02/28/2003, which is hereby incorporated by reference.

FIELD OF INVENTION

The present invention relates to hole saws. Particularly, the present invention relates to hole saws for cutting holes in a in corner regions with spacing requirements such as a web portion of an I-joist.

BACKGROUND OF INVENTION

I-joists are increasingly utilized structural elements in architectural constructions and the like. I-joists are beams that have an I like profile to provide maximum

stiffness and strength with a minimum of weight. I-joists are commonly fabricated in a number of dimensional standards from wood and wood like materials.

Architectural constructions often require the cutting of holes into the web portion of the I-joist to lay pipes, electrical lines and the like across one or more installed I-joist. There exist a number of standards for maximum hole sizes that may be cut into the web portion. Of primary concern is thereby a remaining offset between the web hole and the horizontal top and bottom portion of the I-joist in order to keep the I-joists buckling tendency within safe limits. Therefore there exists a need for a hole cutting apparatus that provides spacing between adjacent sticking out structures while cutting the hole. The present invention addresses this need.

The cutting of large diameter holes at the construction site is mainly accomplished by hand held power tools in which the cutting apparatus is rotatable held. Therefore, for cutting large diameter holes there exists also a need for a cutting apparatus that provides cutting action with minimum friction, reduced peak torque and safe operation without pronounced or sharp features extending beyond the circumference of the rotating apparatus. The present invention addresses also these needs.

SUMMARY

Cutting holes with a hand held power drill or the like may be accomplished in combination with a hole cutting apparatus

concentrically attached to a rotating portion of the power drill. As the hole diameter increases, the resulting torque increases as well. A hole cutting apparatus in accordance with the preferred embodiment of the invention has a number of circumferentially arrayed cutting members configured to keep cutting forces and a resulting cutting torque to a minimum for a given cutting diameter, given axial cutting pressure and a given material of the work piece.

The hole cutting apparatus has a lightweight body including radial beams that connect a central portion with a circumferential ring. Concentrically attached to the central portion is on one side an arbor for attaching the apparatus to the power drill or the like. A pilot drill is attached on the opposite side in coaxial alignment with the arbor. The pilot drill drills a pilot hole into the work piece such that the apparatus is centered during the following hole cutting. The pilot drill extends sufficiently beyond the cutting members to drill the pilot hole sufficiently deep before the cutting members contact the work piece. As the rotating apparatus is forced towards the work piece, cutting edges of the cutting members gradually remove material along an increasingly deep concentric groove until a portion of the work piece inside the concentric groove becomes separated from the remaining work piece.

In the preferred embodiment, the apparatus is configured in combination with dimensional standards of an I-joist. With respect to the present invention, an I-joist is defined as an I-beam profile having a top chord, a bottom chord and a central web portion. The apparatus provides a cutting of

holes in the web portion in accordance with dimensional safety criteria for maximum hole dimensions in the web. The safety criteria are established by I-joist manufacturers for their respective products. Particularly, the ring portion of the apparatus has an outer diameter that corresponds to a height of the web portion between the chord elements such that the apparatus becomes aligned between the top chord and the bottom chord prior to a contacting of the pilot drill with the web portion. The cutting members are in an offset to the ring diameter such that the cutting groove and consequently the hole edge remain in a certain distance to the chords in accordance with the safety criteria.

In the preferred embodiment, three cutting members are circumferentially arrayed to provide an even distribution of cutting pressure onto the individual cutting members. For an I-joist made of wood and/or wood like material, the cutting members may be made of steel, carbide or other material suitable for cutting wood and/or wood like material. The cutting members are preferably mounted in an exchangeable fashion for easy replacement.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 shows a perspective view of a first embodiment of the invention.

Fig. 2 illustrates a side view of the apparatus of **Fig. 1** in operational approach to a preferred work piece.

Fig. 3 depicts a perspective view of the apparatus of **Fig. 1** and the work piece of **Fig. 2** after cutting a hole with the apparatus into the work piece.

Fig. 4 shows a perspective view of a second embodiment of the invention.

Fig. 5 is a top view of the apparatus of **Fig. 4**.

Fig. 6 is a detailed section view of the apparatus of **Fig. 4** in accordance with a section line **A-A** indicated in **Fig. 5**.

DETAILED DESCRIPTION

Referring to **Fig.1**, the present invention is a hole cutting apparatus **100** configured to be attached to a rotating portion of a well known power drill. The power drill may be substituted by other well-known devices configured for receiving and rotating other well known apparatus performing rotating operations. The apparatus **100** is axially attached via an arbor **102**, which may have a hexagonal shape for a rigid interlocking with a three jaw-clamping device of the power drill. The arbor **102** may have other configurations as are well known in the art for transmitting a torque while keeping the apparatus **100** aligned with respect to its rotation axis.

The arbor **102** extends from the backside of a central portion **103** from which preferably three beams or spokes **107** extend in radial direction. The radial beams or spokes **107** connect the central portion **103** with a circumferential ring or rim **101**. The spokes **107** provide a stiff connection between the rim **101** and the central portion **103** while keeping the over all weight of the apparatus **100** to a minimum.

From the front side of the central portion **103** extends a pilot drill **105**, which is in axial alignment with the arbor **102**. An optional spacer **104** may provide a safety space between the pilot drill **105** and the central portion **103** to prevent an inadvertent contacting of the central portion **103** and/or the spokes **107** and/or the rim **101** with a work piece **200** (see **Figs. 2, 3**).

On the rim **101** are circumferentially arrayed and attached a number of groove cutting member **121**, which are configured to gradually remove material from the work piece **200** while keeping friction in the cutting groove to a minimum and while preventing sudden biting of a cutting edge **122** in the cutting groove. For that purpose, the cutting members **121** have a sliding feature **123** placed in front of the cutting edge **122** with respect to an operational rotation direction of the apparatus **100**.

There are preferably three groove cutting members **121** arrayed on the ring **101** to assure equally distributed contact pressure between the individual cutting members **121** and the work piece **200**. The cutting members **121** are preferably attached in a removable fashion in recesses or cavities **109** of the rim **101** and radially fixed via cap screws **124**. Hence, when the cutting members **121** suffer damage or wear, they may be quickly replaced. The invention includes embodiments in which the cutting members **121** are integral part of the ring **101**, which in turn may be replaceable as a whole.

Now turning to **Fig. 2**, the preferred operation of the apparatus **100** may be explained in more detail. The

apparatus **100** is preferably configured for cutting holes **205** (see **Fig. 3**) in a web **204** of an I-beam **200** made of wood and/or wood like material. The I-beam **200,** also known as I-joist **200** has a top chord **201** and a bottom chord **202.** Both chords **201, 202** are spaced apart with distance **212,** which equals the free height of the web **204.** The rim **101** has an outer diameter or circular circumference **111** that is marginally smaller than distance **212.** Consequently, the apparatus becomes vertically substantially aligned once the rim **101** is moved in between the chords **201, 202.** The circular circumference **111** is sufficiently small to prevent excessive friction between the rotating rim **101** and a chord **201** and/or **202.**

The pilot drill **105** protrudes above the rim **101** with an extension **151,** which is sufficiently small to assure positioning prior to contacting of the pilot drill **105** with the web **204.** During operation, the apparatus **100** is brought into rotation via the arbor **102** and brought into contact with the web **204** at a predetermined location. Since the rim **101** assures vertical alignment, the operating person may focus mainly on contacting the pilot drill **105** at a proper longitudinal position along the I-joist **200.**

The drill extension **151** is selected such that the pilot drill **105** drills a sufficiently deep guiding hole into the web **204,** before the cutting members **121** begin gradually removing material and thereby forming an increasingly deep concentric cutting groove. Due to the short circumferential length of the cutting members **121,** chip buildup and associated friction between the cutting members **121** and the cutting groove is kept to a minimum.

While axial pressure is applied via the arbor **102**, the cutting members **121** continue to gradually remove material from the cutting groove until a central portion of the web **204** inside the cutting groove becomes disconnected from the remainder of the web **204**. The cutting members **121** have a height selected in correspondence with a thickness **214** of the web **204** to assure a cutting groove sufficiently deep for separating the central web portion.

The cutting members **121** are positioned in a substantially equal offset **125** to the rim's **101** circular circumference **111**. The offset **125** is selected according to hole cutting standards established by a manufacturer of I-joist **200**. The I-joist **200** may be fabricated in a number of standardized dimensions including a variety of standardized widths **212**. The apparatus **100** may be provided in varying configurations that comply with the varying I-joist standards. As a result, the apparatus **100** may be selected in a prefabricated configuration that corresponds to the dimensional standard of the I-joist **200** for cutting a hole **205** (see **Fig. 3**) that is within the static safety limits for that particular I-joist **200**.

To further reduce friction between the ring **101** and a chord **201** and/or **202**, the outer surface of the ring **101** may be specially treated for reduced friction. Such treatment may include a coating with a low friction material such as Teflon.

The present invention includes embodiments in which a bushing ring or a bearing may be assembled on the rim **101**.

In that case, the circular circumference **111** would be that of the bushing or the bearing.

The present invention is not limited to cutting holes into wooden and/or wood like I-beams. It may also be configured for cutting holes with reduced friction into any kind of work piece. For example, holes may be cut with the apparatus **100** into a metal or stone. In such cases, the cutting members **121** may be accordingly configured for cutting metal or stone as is well known in the art.

In the first embodiment of the invention depicted in the **Figs. 1-3**, the circular circumference **111** is substantially continuous, which warrants a smooth sliding of the rim **101** against adjacent chords **201, 202** during cutting operation. In context with the present invention, the substantially continuous circular circumference **111** pertains to the fact that a projection of the circular circumference **111** in axial direction renders a substantial continuous circle, despite recessing cavities **109**.

In a second embodiment of the invention depicted in the **Figs. 4-6**, the circular circumference **311** has s substantially continuous surface, which means that all main outside boundary edges of the continuous surface are substantially circular and substantially concentric. Cap screws **324** may be accessible through radial rim openings that are not considered as outside boundary edges due to their insignificantly small diameters. The substantially continuous surface provides increased operational safety preventing inadvertent radial thump in case of premature

rotation of the apparatus prior to operational positioning of the apparatus **300**.

An additional safety aspect is the fact that the groove cutting members **121** are fixedly held in cavities **309** that are finite in other than axial direction. Particularly, the cavities **309** are finite in direction radial away from the axis of rotation. Under extreme conditions, where the attachment of the groove cutting members **121** may suffer from impact or the like, the groove cutting members **121** would be held in the apparatus **300** against centrifugal forces.

Fig. 6 illustrates in detail how the groove cutting members **121** are fixedly held in the apparatus **300** via the cap screw **324** radially withholding itself in a press contact in one of the spokes **307** while pressing the groove cutting member **121** against an outside radial wall of the cavity **309**. The cap screw **324** is reaching thereby through an opening of the groove cutting member **121** such that the cap screw **324** head is peripherally accessible through the radial rim opening. The cap screws **324** act thereby additionally as a double supported latch holding with their shaft and head their respective groove cutting members **121** in the cavity **309**.

In contrast the groove cutting members **121** are pressed in the first embodiment against an inside radial wall of the cavity **109**. Also, the cap screws **124** are withholding them self in a tensile fashion, which may require a threads in the spokes **107**.

The cap screws **324** are preferably pressing there associated groove cutting members **121** via a nut **327** that has a

circumferential locking contour corresponding to a rotation lock feature of the cavity **309**. The circumferential locking contour is preferably a flat surface corresponding to a flat bottom of cavity **309** in assembled position. In that case, a flat bottom of the cavity **309** may serve as the circumferential locking contour.

Also in the second embodiment, the groove cutting members **121** may be pressed against the outside radial wall with two bridge contacts **1211** that are in an opposing distance relative to the cap screw **324** such that the groove cutting members **121** are resiliently deflected. This assists in establishing a resilient fix of the groove cutting members **121** that absorbs operational vibrations without becoming loose. Curvature of the groove cutting members **121** may be fabricated accordingly such that it may correspond to the cut groove radius in assembled position.

Rims **101, 301**, spokes **107, 307** and central portions **103, 303** are preferably monolithically fabricated from a lightweight material such as for example, an aluminum alloy, an magnesium alloy, an injection molded plastic or from sheet metal.

The hole cutting apparatus **100, 300** may be fabricated in accordance with exemplary standard diameters for circular circumference **111, 311** listed in inches in the table below.

4.5
5

5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13.0

The preferred offset **125** is about 0.25 inches making the cut holes in diameter approximately 0.5 inches smaller than the circular circumference **111, 311**. An additional spacer insert may be placed in between the groove cutting member **121** and the respective outside wall to slightly reduce the diameter of the cut hole. Such spacer insert would have a preferred thickness of about 0.125 inches.

Accordingly, the scope of the invention described in the specification above is set forth by the following claims and their legal equivalents: